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OPERATING EXPERIENCE WEEKLY SUMMARY

Office of Nuclear and Facility Safety

July 16 - July 22, 1999

Summary 99-29

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1. WORKER SHOCKED BY NEARBY LIGHTNING STRIKE

On July 16, 1999, at the Hanford Site, a worker received a shock, apparently associated with a nearby lightning strike, while working from an aerial lift. Two workers were in the lift basket, approximately 25 ft above the ground. Approximately 3 hr before the event, the supervisor stopped work because of the threat of lightning. He allowed work to resume once he saw the skies clearing, had noticed no lightning activity for nearly 1 hr, and received a report from the site meteorological station indicating that the electrical storm was no longer a threat. Physicians evaluated the worker and released him to return to work. (ORPS Report RL--PHMC-NFUEL-1999-0001)

The two workers in the aerial lift were preparing to replace the deteriorated weather coating on a domed structure. As the lift basket approached the surface of the dome, they saw a flash and heard thunder. The shocked worker felt a jolt and his muscles jerked. He also had the taste of metal in his mouth. The workers immediately lowered the basket to the ground, reported what happened to their supervisor, and then drove to the Hanford Environmental Health Foundation, where a doctor sent the shocked worker to a local hospital for further evaluation. Physicians evaluated the shocked worker and released him.

At any time, some 2,000 thunderstorms are occurring around the world, creating approximately 100 lightning strikes every second. In the United States alone, lightning causes the majority of forest fires and over $2 billion in property losses. Lightning is also the leading weather-related killer in the United States, causing from 100 to 200 deaths every year. In the continental United States, the second and third quarters of the year usually have the most lightning activity. Lightning can measure up to 15,000,000 V and a lightning bolt between a cloud and the ground can travel as far as 8 miles.

Data provided by the National Lightning Safety Institute indicate that 10 percent of lightning strike victims die and 25 percent of the survivors suffer serious long-term aftereffects. Some of the more common aftereffects include memory deficits and loss (52%), sleep disturbance (44%), attention deficits (41%), dizziness (38%), easily fatigued (37%), numbness/paralysis (36%), stiffness in joints (35%), and depression (32%).

These data emphasize the effects of a lightning strike and should encourage everyone to practice lightning safety. The following safety tips from the National Lightning Safety Institute can enhance personal safety during thunderstorms.

- If outdoors, seek shelter. Get indoors or in an all-metal car (except a convertible), truck, or van with the windows shut.
- Avoid bodies of water and all metal objects.
- Get off the high ground. Avoid solitary trees, hilltops, cliff faces, caves, and open spaces.
- If caught away from shelter during a lightning storm, adopt the lightning safety position: stay away from other people, take off all metal objects, and crouch with feet together, head bowed, and hands on knees.
- If indoors, avoid plumbing and other penetrating conductors. Stay away from open doors and windows.
- Hang up the telephone and take off headsets. Turn off appliances, computers, power tools, and television sets. Lightning can strike electric or phone lines and result in a shock.

Additional lightning safety information is available from the National Lightning Safety institute at http://www.lightningsafety.com/.

All employees should receive appropriate training designed to develop a realistic awareness of personal lightning safety. Employees who work indoors should also be trained, because telephones and other indoor electrical equipment can be a source of shocks. Employees working outdoors must understand the nature of the lightning hazard as well as appropriate safety measures.

The following references provide additional guidance on facility lightning protection.

- DOE/EH-0530, Safety Notice 96-04, *Lightning Safety*, contains information about the safety and operational impact of lightning strikes and actions that can be taken to minimize the hazards associated with lighting strikes. This safety notice also contains numerous useful references relating to lightning safety. Safety Notice 96-04 can be obtained by contacting the ES&H Information Center, (800) 473-4375, or by writing to U.S. Department of Energy, ES&H Information Center, EH-72, 19901 Germantown Rd., Germantown, MD 20874. Safety notices are also available at http://tis.eh.doe.gov:80/web/oeaf/lessons_learned/ons/ons.html.

- DOE-O-420.1, *Facility Safety*, provides guidance on natural phenomena hazards mitigation, including lightning, for DOE facilities. The order states that contractors/operators at new sites shall conduct a natural phenomena assessment commensurate with a graded approach to the facility. For existing sites, the contractor/operator shall review and update the natural hazards assessments as necessary and shall conduct a review of the natural hazards assessment at least every ten years.

- NFPA 780, *Standard for Installation of Lightning Protection Systems,* provides guidance for the installation of lightning protection systems. Some of the issues addressed in the standard include installation requirements, a risk assessment guide, and ground measurement techniques.

KEYWORDS: lightning, storm, weather

FUNCTIONAL AREAS: Emergency Planning

2. BOOM OF TRACKHOE PULLS DOWN OVERHEAD LINES

On July 14, 1999, at the Weldon Spring site, a subcontractor operator apprentice driving a trackhoe failed to lower its boom, which then contacted and pulled down a communications cable and a 110-V signal line. The overhead lines, approximately 18 ft above ground level, were attached to a junction box on a pole, and one of the lines was pulled loose from its connections in the junction box. A ground anchor attached to a guy wire on the pole was pulled 2 ft out of the ground, and the messenger cable supporting the lines also broke where it was attached to the pole. The trackhoe operator notified his foreman and the job superintendent of the accident, and they notified contractor and DOE safety supervisors. Site personnel barricaded the area to prevent through traffic and to ensure the safety of personnel in the area. They determined that the communications cable was unnecessary, so it was abandoned. The 110-V signal line was reattached to its terminals, and the pole was straightened and reset into position. Additionally, a 14-in. orange warning ball was attached to the remaining signal line. The failure to follow basic safety requirements while moving heavy equipment or vehicles can cause equipment damage and personnel injury. (ORPS report ORO--MK-WSSRAP-1999-0016)

Investigators determined that the operator had observed the overhead lines before contacting them but did not lower the boom sufficiently to clear the lines as he drove beneath them. They also determined that a spotter should have been assigned during the move to guide the trackhoe operator and assist him in avoiding any obstacles. Failure to assign a spotter is a violation of the Weldon Spring Health and Safety Plan, which states: "All parts of cranes, excavators, lift trucks, trucks with dump bodies, or other lifting equipment working in the area of energized overhead electrical lines shall maintain a minimum clearance of 10 ft from such lines. A person shall be designated to observe equipment clearance and give timely warning of all operations where it is difficult for the operator to maintain the desired clearance by visual means." The apprentice was operating the trackhoe as part of his apprenticeship training, but a journeyman operator should have been walking the equipment in sight of the apprentice.

OEAF engineers searched the ORPS database for recent events where the failure to use spotters and the lack of operator awareness of overhead obstructions caused heavy equipment to contact overhead lines. Some examples follow.

- On April 19, 1999, a forklift operator at the Los Alamos National Laboratory contacted a hanging communications cable with the forklift's mast while maneuvering towards a load. Although the force of the impact snapped a support cable and broke a utility pole crossarm, the communications cable did not break. Investigators determined that the equipment move had been planned and walked down and that spotters were required. They also determined that the forklift operator, without spotters, used a larger forklift than required by the work plan. The communications cable was suspended at a height of 14 ft, and the mast on the larger forklift extends approximately 16 ft vertically with the forks still positioned near the ground. Following the event, the employees who performed the walk-down stated that they had failed to see the low-hanging communications cable. Corrective actions for this event included (1) placing signs on the instrument panels of all forklifts exceeding 10-ton capacity to alert the operators of the minimum and maximum heights of the mast and (2) requiring forklift operators to perform a walk-down and identify potential hazards before beginning work. (ORPS Report ALO-LA-LANL-CHEMLASER-1999-0003)

- On November 23, 1998, the boom of a trackhoe being driven by a subcontractor operator at a peripheral property of the Grand Junction Projects Office struck a 440-V overhead electric utility line. The power line was clearly visible, with no obstructions, and the work crew, including the trackhoe operator, had recently attended a safety briefing that specifically addressed the overhead power line and the procedure to be followed when moving equipment near it. The line was high enough to allow the trackhoe easy passage underneath provided the boom was lowered. Additionally, the supervisor of the trackhoe operator had discussed the overhead line with him and had instructed him to ensure the trackhoe boom was lowered while passing under the line. To prevent recurrence of this event, the work procedures were modified to include requiring a spotter when moving heavy equipment under power lines and locating power line warning signs at least 25 ft from them. (ORPS Report ALO--MCTC-GJPOTAR-1998-0013)

- On September 24, 1997, the boom of a trackhoe being relocated to a different site by a subcontractor operator in an area adjacent to the Oak Ridge Y-12 Site contacted and severed an overhead 120-V power line. The overhead line was 14 ft, 2 in., above ground level and the fully retracted boom of the trackhoe was 9 ft, 2 in. high. Previous training, including a pre-job brief the morning of the event, required equipment operators to fully retract the trackhoe boom when moving near overhead lines. The operator said immediately after he severed the line that he had forgotten about the line and had neglected to lower the boom. Corrective actions for this event included (1) attaching flagging to the overhead line to make it more visible, (2) posting signs at the approach to the line, and (3) revising the

activity hazard analysis for the work to require a spotter while heavy equipment was operated near any overhead lines. (ORPS Report ORO--LMES-Y12ENVRES-1997-0001)

These events demonstrate the importance of exercising extreme caution when operating heavy machinery such as trackhoes, forklifts, fork trucks, and cranes in the vicinity of overhead obstructions. DOE facility managers should ensure that facility personnel and off-site vendors who operate equipment on site property are aware of any overhead hazards and that these hazards are clearly marked for clearance requirements and visibility. Work planners should inspect overhead hazards and clearances at job sites and over entire routes to be traveled by heavy equipment. Identified hazards should be described in work documents and thoroughly discussed in pre-job briefings. Equipment operators should walk down areas to identify and evaluate overhead hazards. Spotters should be required for all construction activity involving heavy equipment. They should be required for any movement of heavy equipment in the vicinity of obstructions and should have no other duties while heavy equipment is in use. Operators should be prohibited from operating or moving equipment unless a spotter is present.

OSHA regulation 29 CFR 1926.550(a)(15)(iv), “Cranes and Derricks,” states that a person shall be designated to observe clearance of the equipment and give timely warning for all operations where it is difficult for the operator to maintain the desired clearance by visual means. Section 1926.600(a)(6), “Equipment,” states: “All equipment covered by this subpart shall comply with the requirements of 1926.550(a)(15) when working or being moved in the vicinity of power lines or energized transmitters.” Section 1926.550(a)(15) requires a minimum clearance of 10 ft between any part of the crane or load and lines rated 50 kV or below, even if spotters are used.

KEYWORDS: construction, equipment, industrial safety, job planning, overhead, pole, power line, safety hazard

FUNCTIONAL AREAS: Construction, Industrial Safety, Work Planning

3. BREAKER FIRE LEADS TO SITE AREA EMERGENCY AT IDAHO

On July 12, 1999, at the Idaho Nuclear Technology and Engineering Center (INTEC), an emergency director declared a site area emergency when several facilities experienced a partial loss of standby electrical power after a 13.8-kV breaker failed catastrophically, causing a fire and dense smoke. Substation personnel secured all commercial power at the fire department’s request, but one of three INTEC generators failed to start and a second standby generator started but shut down later because of high cooling water temperature. In addition, INTEC personnel shut off normal telephone services to preserve other vital alarm functions when the battery for the telecommunications system began to weaken. After commercial power was restored, power distribution anomalies prevented INTEC personnel from restoring power in two facilities until the following day. Investigators are evaluating whether a rat, found dead inside the damaged breaker, caused the fire. Although there were no personnel injuries and no spread of contamination outside of controlled areas, the loss of commercial power resulted in numerous unanticipated system upsets, indicating potential configuration control problems. (ORPS Report ID--LITC-LANDLORD-1999-0008)

Investigators determined that the third INTEC standby generator started automatically and supplied high-level waste process and ventilation loads throughout the event. They also determined that New Waste Calcining Facility (NWCF) personnel were unable to manually start the NWCF standby generator after it failed to start automatically. Personnel later evacuated the facility when batteries for the uninterruptible power supply system for the NWCF distributed control system became depleted, causing a total loss of power to the facility. After power was restored, NWCF personnel discovered three radiologically contaminated areas within facility radiological buffer areas that were not contaminated before power was lost. They believe these areas became contaminated as a result of ventilation system upsets that occurred during the loss of power event.

Facility personnel evacuated the Fuel Receiving and Storage Facility and the adjacent Irradiated Fuel Storage Facility when commercial power was lost and standby power was unavailable. Although the standby generator started automatically, power was not being automatically routed to the facilities because of a power distribution system upgrade project that was underway. Power management and operations personnel had procedures to manually route standby power to the facilities upon a loss of commercial power. However, because INTEC electricians were engaged in higher priority activities, including attempts to start the NWCF standby generator, no one was available to manually route standby power to the facilities. In addition, the standby generator shut down on a high cooling water temperature alarm approximately 2 hr after it had automatically started.

Figure 3-1 shows the failed breaker and Figure 3-2 shows a closeup of the center phase of the breaker and the dead rat. INTEC personnel are continuing to investigate this event. In addition to investigating the standby generator and battery issues, INTEC personnel will investigate the relationship between sitewide emergency action levels and non-safety-related, non-emergency diesel generators. OEAF engineers will continue to follow this event and will provide additional information when it becomes available.

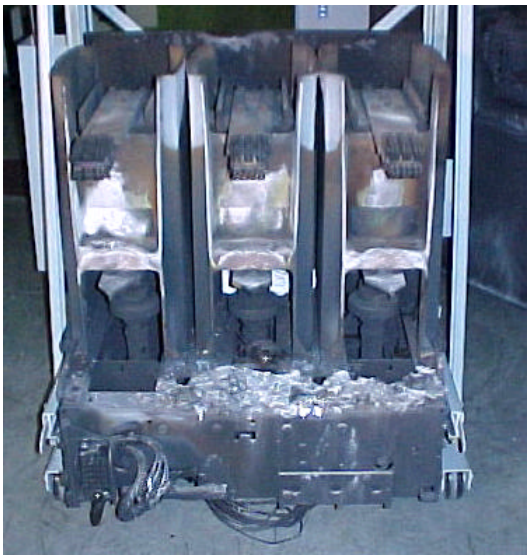

Figure 3-1. Failed Breaker

Figure 3-2. Failed Breaker with Rat

NFS has reported diesel generator problems in several Weekly Summaries. Some examples follow.

- Weekly Summary 98-15 reported that maintenance workers at Hanford discovered that one of the starting batteries for a diesel generator was dead. Investigators determined that the subcontractor mechanic did not realize that the specific gravity for it was slowly declining. If the contractor had noticed the slow decline, the battery could have been replaced before it failed. (ORPS Report RL--BHI-DND-1997-0007)

- Weekly Summary 97-51 reported that a misconfigured transfer switch at the Argonne National Laboratory—West prevented the transfer of electrical power from a diesel generator to the electrical system. Test personnel could not complete a quarterly diesel generator load test because a mechanic had left the mechanical transfer arm of the transfer switch in the wrong position following annual preventive maintenance. (ORPS Report CH-AA-ANLW-AL-1996-0003)

These events illustrate the importance of implementing an effective maintenance program to ensure that facility equipment remains operable and a disciplined configuration management

program exists to ensure safe operation, testing, and maintenance of facility equipment and systems. Equipment must be routinely maintained to ensure it can perform its intended function. Facility managers should ensure that all personnel are aware of the need for a stringent configuration management change control process, even for nonvital systems. These events also demonstrate the importance of multiple barriers to prevent hazardous events such as the loss of standby power. When multiple barriers fail, managers should investigate to determine if broad programmatic deficiencies exist.

Facility managers should review the following to ensure that procedures and programs exist that ensure the facility equipment will operate as designed.

- DOE O 5480.19, *Conduct of Operations Requirements for DOE Facilities*, chapter VIII, "Control of Equipment and System Status," states that DOE facilities are required to establish administrative control programs to handle configuration changes resulting from maintenance, modifications, and testing activities.

- DOE-STD-1073-93-Pt.1 and -Pt.2*, Guide for Operational Configuration Management Programs, Including the Adjunct Programs of Design Reconstitution and Material Condition and Aging Management*, provides guidelines and good practices for an operational configuration management program including change control and document control.

KEYWORDS: configuration management, diesel generator, battery

FUNCTIONAL AREAS: Configuration Control, Emergency Planning

4. SCREW PENETRATES SWITCHBOX CAUSING ELECTRICAL SHORT CIRCUIT

On July 7, 1999, at Los Alamos National Laboratory, a Contract Associates worker short-circuited electrical power in a room at the Tritium Facilities when he penetrated a metal switchbox and hit an energized 120-V ac wire with a mounting screw. The worker was installing wall units for modular furniture to a concrete block wall. The switchbox, which controlled room lighting, was located on the other side of the wall from the penetration location. The worker used a manufacturer-provided screw that was longer than the depth of the hole that had been predrilled according to the specifications of an approved penetration permit. The screw penetrated an existing ¼-in.-diameter hole in the switchbox with which it was coincidentally aligned, chewed through the wire insulation, and caused a high-impedance short circuit. The wire and screw were burned in half. Although no injuries occurred during this event, penetrating energized electrical utilities can result in serious injury, equipment damage, and disruption of facility services. (ORPS Report ALO-LA-LANL-TRITFACILS-1999-0001)

The Facility Management Unit had authorized work using an approved penetration permit for Contract Associates to install the wall units. The workers drilling the holes conformed with the permit requirements to use protective electrician's gloves, eye protection, and insulated tools. A drilling depth of 1½ in. into the concrete block wall was specified as a limit for the penetration. The workers used a Model 120/1 Metalla Portable Metal and Power Detector to locate wires inside the wall. The detector located the metal switchbox and the workers determined it to be beyond the 1½-in. penetration depth. They did not detect electrostatic current at the surveyed location.

One of the workers drilled a hole in the 4-in.-thick wall to a depth of 1½ in., the last ¼ in. exactly coinciding with an existing hole in the switchbox. He inserted a 1½-in. long plastic anchor in the hole and ran a 2½-in. long screw (provided by the manufacturer) into the anchor with a battery-powered portable screw gun (drill). The worker was not wearing gloves at this time. Approximately 1 in. of screw penetrated the box and contacted the energized wire. The worker

saw sparks and cleared the short circuit by backing out the screw approximately 10 seconds after the arcing began. The circuit breaker for the lighting

circuit did not open. The worker donned dielectric gloves before he removed the damaged screw from the switchbox. He then placed red electrical insulating tape over the hole and contacted the facility coordinator and the Contract Associates installation manager. A facility electrician locked out the circuit breaker, opened the switchbox, and repaired the burned wire with a splice.

Investigators determined that the activity hazard analysis for penetration did not distinguish a separate step for driving screws into the predrilled holes to install wall tracks. As a result, the workers were not wearing dielectric gloves while driving screws into the predrilled holes. Facility managers were unaware that Contract Associates workers used manufacturer-provided standard screws that were 2½-in. long. Investigators also determined that the workers knew that a wall switch for room lights was on the other side of the wall, but the location of the switch and cover plate made it appear that the box would not be behind the point of the penetration. An electrical safety officer tested the tester used by Contract Associates on the subject wall. The metal box was clearly detected, but the electrical energy was not apparent on the device until the lights were turned on and there was current flow. Following a critique of the event, facility managers had the penetration permit for the Contract Associates installation revised to restrict the length of screws so they do not exceed the depth of the 1½-in. drilled holes and to require workers to wear dielectric gloves for driving screws.

NFS has reported other events in the Weekly Summary in which energized electrical service was contacted while drilling into walls and floors. Some examples follow.

- Weekly Summary 99-25 reported that a pipe fitter at the Pantex Plant penetrated an electrical conduit while drilling a hole in a wall for a subcontractor. The drill did not damage the energized 480-V wires inside the conduit. The subcontractor had marked the location for the penetration but had incorrectly measured the location of the conduit mounted on the opposite side of the wall. Investigators determined that the pipe fitter knew there was a conduit on the other side of the wall but relied on the subcontractor's mark. (ORPS Report ALO-AO-MHSM-PANTEX-1999-0042)

- Weekly Summary 99-17 reported that craftsmen at the Mound Plant penetrated a conduit containing four energized 110-V circuits while core-drilling a concrete floor. Investigators determined that the craftsmen did not have a permit for core drilling, which would have required personnel to scan the area for hidden utilities using utility locating equipment. (ORPS Report OH-MB-BWO-BWO03-1999-0001)

- Weekly Summary 99-07 reported that technicians at the Rocky Flats Environmental Technology Site drilled into two energized 120-V electrical lighting circuits while installing a telephone line in a trailer, causing two 20 amp circuit breakers to trip. Investigators determined that the integrated work control package failed to require the use of a utility locator before drilling to determine if electrical wiring was present or the installation of a lockout/tagout if wiring was located. (ORPS Report RFO--KHLL-779OPS-1999-0007)

These events illustrate the importance of using and following the requirements identified in penetration permits. The depth (1½ in.) specified in the permit in the Los Alamos event is a standard depth to prevent contact with hidden obstructions such as reinforcing bars. Indeed, this specified depth would have prevented the event had it not been the case that the mounting hardware used by the installers exceeded the permitted depth. Personnel should ensure that tools and fasteners are within the requirements of the penetration permit. Also, when an electrical service is involved, the safest course of action is to have it de-energized and locked out. As an additional precaution, workers should use double-insulated tools, rubber mats, electrically rated gloves, and ground-fault circuit interrupt circuits for power tools. Facility

managers and work planners should review the following references when planning penetration work.

Lessons Learned Report, Issue 98-02, *Penetrating Hidden Utilities,* includes lessons learned from events that involved cutting and drilling into utilities concealed behind walls, floors, and ceilings. It also provides recommendations for avoiding hidden utilities and includes useful references. The recommendations include (1) checking drill holes frequently for signs of obstructions, (2) stopping to investigate if an obstruction is hit, (3) marking the location of utilities, and (4) using drills equipped with electronic drill stops. Lessons Learned Reports are available at http://www.tis.eh.doe.gov/web/oeaf/ lessons_learned/reports/.

29 CFR 1926.416(a)(3), *Protection of Employees*, states that employers shall ascertain by inquiry, direct observation, or instruments whether any part of an energized electrical circuit is located such that the performance of work may bring any person, tool, or machine into contact with it. OSHA regulations define concealed wiring as wiring rendered inaccessible by the structure or finish of the building. OSHA regulations are available at http://www.osha-slc.gov/OshStd_data.

KEYWORDS: electrical hazard, energized equipment, penetration, short circuit, switch

FUNCTIONAL AREAS: Industrial Safety

5. HALON SYSTEM MAINTENANCE CREATES UNSAFE CONDITION

On July 14, 1999, technical maintenance service (TMS) personnel at the Savannah River Site discovered that two Halon bottles that had been disconnected from a Halon system at the Effluent Treatment Facility were capped with pipe caps instead of vented plugs. They notified facility operating personnel, who checked the Halon system and found that the headers from which the bottles had been disconnected were capped with vented plugs. The Halon bottles should have been capped with vented plugs for transport and the headers should have been capped with pipe caps. This occurrence is significant because had a fire occurred, an operator would have entered the Halon bottle room and manually dumped Halon from one or both of the remaining two Halon bottles. This action would have discharged Halon from the vented plugs within 2 ft of the operator. Also, the vented plugs would have allowed Halon to bypass the main discharge header. (ORPS Report SR--WSRC-ETF-1999-0004)

Configurations and designs for Halon systems and components vary widely. It is a design anomaly of this particular system that the plugs and caps can be interchanged. Figure 5-1 shows a vented plug and a pipe cap.

Figure 5-1. Halon System Vented Plug and Pipe Cap

Figure 5-2 shows an intact Halon bottle installation, a manual discharge station, and a properly capped header. Figure 5-2 illustrates that it is possible to break the union at the large pipe nipple just above the discharge head in a way that allows reversal of the intended cap and plug configuration.

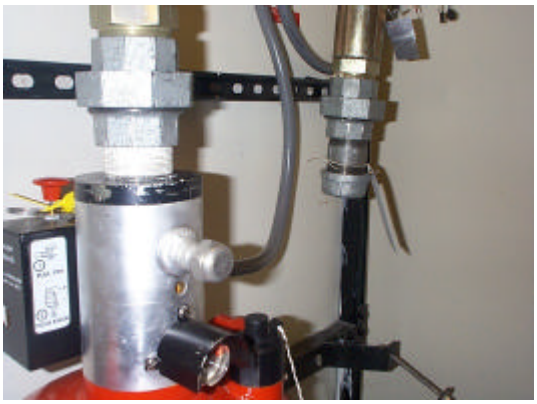

Figure 5-2. Halon Installation

Facility personnel immediately declared the Halon system out of service and tagged the Halon bottle room door to control access. They retrieved the pipe caps from the TMS organization and installed them in place of the vented plugs. Participants at a critique of the occurrence learned that the procedure for removing Halon bottles merely states, “Disconnect the Halon bottles.” It relies on skill-of-craft and contains no information on capping headers or plugging Halon bottles. They also learned that members of the operating organization are responsible for operating Halon systems but receive little or no training on them. Consequently, they may not recognize an unsafe configuration.

The following are among several occurrences reported to ORPS in which an inadequate work plan or procedure for fire suppression system maintenance has caused system degradation or safety hazards. NFS has reported two of them in the Weekly Summary.

- On December 18, 1998, at the Savannah River Plutonium Processing and Handling Facility, a cylinder containing 33 lb of Halon completely discharged as fire protection personnel were removing it from service for scheduled checks. Workers had not yet removed the cylinder from the cylinder brackets, and no personnel were injured. The Halon system contained cylinders and pneumatic actuators supplied by two different manufacturers, Ansul and Halax. On both types, inert gas pressure at 150 percent of cylinder pressure holds the discharge valve closed. As a good practice, workers install a safety cap over the discharge valve before they move a cylinder. In this case, however, they installed a safety cap for a Halax actuator over the Schraeder valve for an Ansul actuator. The improper cap opened the Schraeder charging valve, released pneumatic pressure from the actuator head, and initiated the Halon discharge. The governing procedure did not contain guidance for selecting the proper safety cap or warnings regarding inspection or accidental actuation of Schraeder valves. (ORPS Report SR--WSRC-FBLINE-1998-0034)

- Weekly Summary 99-02 reported that two firefighters at the Brookhaven National Laboratory were slightly injured when one of them accidentally discharged an 800-psi carbon dioxide cylinder. The discharge propelled the cylinder from a cart that workers had used to transport it to a parking area. The cylinder spun out of control and struck one of the firefighters on the calf, inflicting a deep-muscle bruise. The other firefighter fell as he was trying to avoid the cylinder and experienced a scraped elbow and knee. Investigators for this occurrence determined that workers who removed the cylinder from service had not removed the discharge

head nor had they installed a safety cap or a diffuser cap. They also determined that the firefighters had been working without a written procedure or checklist. (ORPS Reports CH-BH-BNL-BNL-1998-0041)

- Weekly Summary 98-38 reported that fire department personnel at the Hanford Site Plutonium Finishing Plant were performing a Halon system functional test when the Halon system discharged. The discharge occurred when electricians disconnected wires from a Halon tank pressure-monitoring instrument instead of a Halon discharge actuator. They were working under a generic work package for preventive maintenance of site fire protection systems. The work package did not provide details for deactivating the Halon system and did not include a wiring diagram. (ORPS Report RL--PHMC-PFP-1998-0040)

These occurrences underscore the importance of detailed procedures for maintenance of fire suppression systems and training in the use of them. Improper maintenance activities can lead to unexpected personnel hazards and undetected degradation of fire suppression capabilities. Corrective actions for the Halon bottle discharge occurrence at Savannah River included development of site-level procedures with detailed instructions and diagrams for the safe impairment and restoration of Ansul Halon cylinders. Corrective actions such as these, however, should be applied not only to demonstrated trouble areas but to all routine fire suppression system maintenance activities where consistent performance is required as a matter of personnel or facility safety. Work plans for one-time maintenance or troubleshooting of fire suppression systems should also contain detailed instructions specific to the task at hand. Finally, it is good practice to require inspections by qualified fire protection engineers when fire suppression systems or components are impaired and after they are restored to service.

The Hanford Plutonium Finishing Plant performed a Type C investigation of the 1998 inadvertent Halon system discharge occurrence and four similar occurrences. The facility manager incorporated the results of this investigation into the final report for ORPS Report RL--PHMC-PFP-1998-0040. The investigation report concludes in part that procedures prepared for fire systems maintenance and testing lack sufficient detail to allow successful performance of the tasks. The practice at that time was to make the procedures general enough to be usable for the various similar installations across the site. This practice required users to apply technical expertise with the systems to supplement written instructions. Fire systems maintenance managers misjudged the skill level of the crafts and did not ensure the correct amount of detail in the procedures. While procedures had been improved after each of the analyzed events, they still lacked the detail to prevent another occurrence. Investigators also concluded that fire systems maintenance managers need to determine the skill level of the craft, align the skill level to the level of detail provided in procedures, and evaluate the need for specific procedures for individual suppression systems.

DOE-STD-1029-92, *Writers Guide for Technical Procedures*, provides guidance to assist procedure writers across the DOE complex in producing accurate, complete, and usable technical procedures that promote safe and efficient operations. This guidance can also be applied to other technical documents such as work plans. Section 3.1.1, “Appropriate Level of Detail,” states that the complexity of a procedure should increase as task complexity and the amount of standardization desired increase, and may decrease with increased task frequency and the qualification level of users. Although some tasks are performed frequently and seem straightforward, procedure writers must also consider the consequences of improper performance when they are choosing the level of detail.

KEYWORDS: fire suppression, Halon, maintenance, procedure, work planning

FUNCTIONAL AREAS: Fire Protection, Mechanical Maintenance, Procedures, Work Planning

6. EXPIRED WORKER CERTIFICATION VIOLATES TECHNICAL STANDARD

On July 15, 1999, at the Idaho Nuclear Technology and Engineering Center (INTEC), an operations supervisor discovered that a facility shift supervisor was present on two occasions during sampling activities after his required Foreman III certification had expired on May 31, 1999. This is a violation of the INTEC technical standard for staffing requirements for qualified/certified personnel because the sampling activity required the presence of a certified Foreman III. The operations supervisor also discovered that another of his 13 shift supervisors had expired Foreman III training, but this shift supervisor did not perform operations in violation of staffing requirements. Both shift supervisors have been restricted from performing Foreman III activities until they complete their recertification. Expired training can lead to a decrease in worker proficiency and knowledge and may have an adverse impact on the environment and on the safety of personnel. (ORPS Report ID--LITC-WASTEMNGT-1999-0009)

INTEC operations personnel create a certifications status report manually once per month using training tracking system information. When they identify an employee whose certifications are about to expire, they notify the employee and his or her supervisor that the employee must complete the required training.

Investigators determined that an INTEC training organization report noted that the shift supervisor's certification was about to expire. However, the report preparer overlooked the supervisor's name and failed to send the required notifications. Facility managers conducted a critique of this event. Critique attendees said that the current system for identifying when worker certifications are about to expire lacks systematic rigor. They also said that there have been four similar events at the Idaho National Engineering and Environmental Laboratory (INEEL), two of which were reportable to ORPS. Attendees recommended returning to a training expiration notification system that was successfully used by the previous operating contractor.

NFS has reported occurrences involving expired qualifications in several Weekly Summaries. Following are some examples.

- Weekly Summary 98-44 reported that training staff personnel at the Los Alamos National Laboratory checking training records discovered that a contractor employee had never received biennial general employee radiological refresher training and that he was initially trained over two years earlier. Investigators determined that the employee was improperly permitted access to radiological areas after his training had lapsed because a deactivation date had been incorrectly entered into an access control system. (ORPS Report ALO-LA-LANL-WASTEMGT-1998-0005)

- Weekly Summary 98-11 reported two events at the Hanford Site, where workers with expired qualifications entered radiological areas because of incorrect information in the site-wide Access Control Entry System (ACES). The ACES is an automated system used to track radiological and hazardous waste work package requirements and worker radiological and hazardous waste safety training. At the Fast Flux Test Facility, a radiation control technician granted a thermal insulation worker access to a radiologically controlled area based on erroneous data in the ACES. The ACES administrator failed to update the system when training personnel informed him that the insulation worker had failed a module of the computer-based training for Radiation Worker II requalification. At the Pacific Northwest National Laboratories, personnel in the radiochemical processing group discovered that Radiation Worker II qualifications for a worker had expired. The worker had been entering radiologically controlled areas after his qualifications expired because information in the ACES indicated that his training had not yet expired. (ORPS Reports RL--PHMC-FFTF-1998-0005, RL--PNNL-PNNLNUCL-1998-0002)

- Weekly Summary 97-05 reported that a waste generation custodial officer at the Savannah River Site FB-Line discovered that the annual Resource Conservation and Recovery Act (RCRA) training for six waste-handling operators had expired. While conducting an internal audit of RCRA training qualifications, the officer found the operators had performed RCRA-related waste handling activities after their annual training expired. (ORPS Report SR--WSRC-FBLINE-1997-0006)

- Weekly Summary 96-50 reported that during an ongoing review of personnel qualification/certification records at the Pantex Plant, Manufacturing Division personnel determined a production technician was performing work for which she was not fully qualified. The technician returned to the job she was doing after several years in another position on site. Although she had completed all required job-specific training, she lacked courses on general work practices required by plant procedures. The Manufacturing Division director immediately removed the technician from her assignment. (ORPS Report ALO-AO-MHSM-PANTEX-1996-0236)

OEAF engineers searched the ORPS database for the similar events at INEEL mentioned by critique attendees and found two events at Test Area North Operations. Engineers also reviewed ORPS final reports for the five events mentioned in previous Weekly Summaries. Causes and corrective actions in these seven events varied, but misunderstood or uncommunicated roles and responsibilities were the leading contributors to lapsed certifications.

These events illustrate the need for training coordinators, supervisors, and employees to review their training program records and controls to ensure that employees are qualified and certified for the tasks to which they are assigned. Employees should also accept the responsibility for meeting qualification requirements. Training organizations should inform supervisors of required employee refresher training so supervisors can easily track the status of training for workers. This allows supervisors to assign work to qualified workers and allows them to schedule training in an effective manner.

- DOE 5480.20, *Personnel Selection, Qualification, Training, and Staffing Requirements at DOE Reactor and Non-Reactor Nuclear Facilities,* provides requirements for ensuring that all workers are qualified to carry out their assigned responsibilities. Chapter I, section 7.a.(1) and 7.a.(2), provide requirements for developing and maintaining training to meet the position requirements. Requirements for initial and continuing training can be found in sections I.7.c and I.7.d.

- DOE-STD-1060-93, *Guide to Good Practices for Continuing Training*, chapter 7, requires auditable records of personnel training. It also states that supervisors "should have access to qualification records, as necessary, to support the assignment of work to qualified personnel."

KEYWORDS: access control, administrative control, training and qualifications

FUNCTIONAL AREAS: Training and Qualification

7. ELECTRICIAN VIOLATES ELECTRICAL SAFETY REQUIREMENT

On July 8, 1999, at the Weldon Spring Site Water Treatment plant, a subcontractor electrician was working within 3 to 5 ft of an energized 480-V power line while he was installing conduit on top of a power pole from an aerial lift. A construction engineer observed the electrician in the lift and realized the power line was still energized. The engineer had the electrician lower the basket to the ground and stopped the work activity. Earlier in the day, while the electrician was preparing to work, a safety supervisor asked him if the power line had been locked out/tagged out, because the aerial lift was not insulated. The electrician, who was responsible for locking

out/tagging out the line, replied that it was even though it wasn't. A task-specific safety assessment prepared for the work specifically required the line to be locked out/tagged out before working in its vicinity, and the electrician was aware of this requirement. Violation of safety requirements can cause serious personnel injuries, fatalities, and costly damage to facilities and equipment. (ORPS Report ORO--MK-WSSRAP-1999-0015)

Investigators determined that the electrician was trained on the safe use of an aerial lift and was aware of the hazards associated with using an aerial lift near energized power lines. Investigators also determined that the electrician had not yet received Weldon Spring site-specific lockout/tagout training and was not qualified to perform the lockout/tagout. Facility managers do not know why the electrician began his work before the line was locked out/tagged out. They determined that his foreman, who was not in the work area, inadequately supervised the electrician. The subcontractor project manager dismissed the electrician from the job and the site and replaced him so the work could be safely finished. As a corrective action, the construction engineer and the safety supervisor will periodically check to ensure that lockouts/tagouts are applied when required by a work plan.

OEAF engineers searched the ORPS database for other events where safety rules were willfully violated. Some examples follow.

- Safety inspectors at the Argonne National Laboratory—East observed subcontractor personnel climbing a 200-ft meteorological tower without using the fall protection specified by the safety plan approved for the work. The subcontractor personnel had arrived at the site without the appropriate equipment and were not aware that it was required. A site safety professional prohibited them from climbing until they had the required equipment and site safety representatives had inspected it. Ignoring the prohibition, the workers began climbing the tower a few hours later without the required equipment. The subcontractors' managers were informed that future proposals for conducting work at the site would be accepted only if subcontractor managers visit the site and assure site personnel that work crews will conform with all the requirements in the safety plan approved as part of the procurement agreement. (ORPS Report CH-AA-ANLE-ANLEERD-1999-0002)

- A subcontractor electrician at Brookhaven National Laboratory performing work under an approved work plan on a fan motor and motorized louvers closed a 110-V supply breaker to test his work. The breaker had a red danger tag on it with explicit instructions that the breaker should not be operated while the tag was attached. The tag also gave the breaker number, identified the equipment the breaker was protecting, and explained why the tag had been installed. Although he had received lockout/tagout training and had been informed at a pre-job briefing that the tag would be installed on the breaker for his protection, the electrician knowingly violated the lockout/tagout. The electrician was disciplined for his actions and removed from the job. (ORPS Report CH-BH-BNL-HFBR-1994-0002)

- An electrician at Los Alamos National Laboratory was using a pull wire to run electrical wiring through newly installed conduit into an energized 480-V motor control center (MCC) when the pull wire contacted the energized bus-work and produced a fault that tripped the MCC's main feeder breaker. The electrician had incorrectly run the conduit into an energized bus compartment rather than into the deenergized wiring compartment. The electrician said that he knew that he had been mistaken in the location of the conduit but decided to finish the job. In his own words, he "took a chance to get the job done." Investigators determined that the electrician's foreman was also negligent because he failed to adequately supervise the electrician's work, obtain a required energized work permit for work on or near energized circuits, or provide assistance when the electrician asked for it. Despite having received electrical safety training, the electrician violated electrical safety procedure requirements by working alone near energized circuits,

not having the energized work permit, and not using adequate personal protective equipment. He and his supervisor received disciplinary action for collective willful violations of electrical safety requirements. (ORPS Report ALO-LA-LANL-RADIOCHEM-1994-0002)

DOE site operators require both their own personnel and subcontracted personnel to submit safety plans for any work that might involve environmental, safety, or health hazards. Safety professionals review the safety plans for adequacy and approve them. Contract provisions require the prime contractor and subcontractors to adhere to safe work practices and to observe safety requirements. Work control procedures require pre-job briefings for workers so that they understand the safety requirements. Nonetheless, violations of electrical and other safety requirements continue to occur throughout DOE. The Weldon Spring electrician's limited concern for electrical safety indicates that he and his foreman lacked an incentive to adhere to DOE electrical safety policies and procedures. The failure of subcontractors to observe safety requirements specified in procurement agreements is a frequent root cause in many near-miss events. There are compelling reasons for adhering to electrical safety policies and procedures. Following the policies and procedures not only helps to ensure that personnel are safe from electrical hazards on the job, it also helps to ensure that the job gets completed. In addition to nearly causing a serious injury or even death, the chance taken by the electrician in this event resulted in a delay in getting the job done.

DOE/EH-0557, Safety Notice 98-01, *Electrical Safety*, contains summaries, corrective actions, and recommendations related to electrical events. It notes that more than 800 occurrences involving electrical safety were reported in ORPS between January 1990 and June 1998.

DOE-HDBK-1092-98, *Electrical Safety,* contains explanatory material in support of OSHA regulations and nationally recognized electrical-safety-related standards. It discusses electrical job site safety rules and states: "Prior to beginning any work at the job site, an individual should be designated as the person to be responsible for seeing that the safety rules are followed and to coordinate all the work activities. All personnel assigned to the job shall comply with the safety rules." The handbook also discusses the latest editions of 29 CFR 1910 and 29 CFR 1926 and National Fire Protection Association Standard 70E, *National Electrical Code*.

DOE O 4330.4B, *Maintenance Management Program*, chapter II, section 8.3.6, "Control of Non-Facility Contractor and Subcontractor Personnel," states that nonfacility contractor and subcontractor managers should be held accountable for the work performed by their personnel. Section 8.3.3 requires maintenance supervisors to routinely monitor maintenance activities, including industrial safety practices, to ensure they are in accordance with DOE and facility policies and procedures.

The possibility of severe injury or death is too great to justify not following safe electrical work practices. It is extremely important to strictly enforce all electrical safety policies and procedures. Surveillance and supervision of subcontractor compliance with all safety requirements should be an important component of any work plan. Facility managers should demonstrate that they will not tolerate personnel exposing themselves and others to harmful situations by the willful, voluntary, and knowledgeable violation of safety procedures.

KEYWORDS: contractor controls, electrical safety, supervision, violation

FUNCTIONAL AREAS: Industrial Safety

8. FAILURE TO USE SPECIFIED LIFTING SLING VIOLATES AUTHORIZATION BASIS

On July 14, 1999, at the Pantex Plant, an operations manager discovered that production technicians had been lifting nuclear weapons and nuclear-explosive-like assemblies (NELA) without using a dielectric sling, as required by the building basis for interim operations (BIO). This is a violation of the authorization basis. The procedures used by the production technicians did not specify which lifting device to use. This event is significant because the authorization basis requirements for the weapons program were not included in the procedures used to lift and move weapons and NELAs. (ORPS Report ALO-AO-MHSM-PANTEX-1999-0051)

The operations manager was performing an inventory of tools in the building and requested that the facility manager remove a web sling from the facility operations specific status tracking board, which tracks the expiration dates of tools. The facility manager asked that the operations manager contact Engineering and Design to determine if the sling could be removed from the board. Personnel from Engineering and Design told the operations manager that the sling could not be removed because the BIO required it to be used for moving nuclear weapons and NELAs. The dielectric sling provides electrical isolation from the metal lifting fixture (strong back) in case the building is struck by lightning.

Investigators determined that because the engineering group had not used the BIO when it was developing procedures, the requirement for use of the sling was never incorporated in this procedure for the weapon program. They also determined that only two procedures out of five weapon program procedures correctly called for the use of the sling. The facility manager initiated administrative controls to prohibit moving weapon units into the building. The engineering group is revising the procedures for the lifting operations.

NFS has reported events in the Weekly Summary involving inadequate implementation of authorization basis requirements, and OEAF engineers have identified numerous occurrences of this type in the ORPS database. Two examples follow.

- Weekly Summary 99-26 reported that operating personnel at the Argonne National Laboratory—West Fuel Conditioning Facility determined that an operating instruction for control of keys was inconsistent with the approved Technical Safety Requirements (TSR). The key controls described in the TSRs implement a two-person rule for the handling of special nuclear material at a Security Category I facility. Changes in the facility mission resulted in its downgrade to Security Category III, and the facility has maintained that level of security since startup in 1996. Investigators determined that there was a deficiency in linking the TSRs with the implementing instructions and procedures. (ORPS Report CH-AA-ANLW-FCF-1999-0003)

- On March 11, 1999, at the Los Alamos National Laboratory Chemistry and Metallurgy Research Facility, a DOE review team discovered that a facility surveillance procedure for limiting combustible materials loading did not include all of the rooms subject to monthly inspections. The team was reviewing the Interim Technical Safety Requirements (ITSR). When the ITSRs were being developed, facility and DOE personnel had discussed the possible exclusion of ten rooms from the surveillance requirement. The surveillance procedure was written and approved before final approval of the ITSRs. Procedure developers did not realize that the exclusion had not been incorporated into the authorization basis, and facility managers did not cross-check the procedure against information in the approved ITSRs. (ORPS Report ALO-LA-LANL-CMR-1999-0006)

These occurrences underscore the importance of maintaining positive control of requirements contained in the authorization basis. Facility procedures must fully implement the requirements of the authorization basis and they must be adequately reviewed before they are approved to

ensure that they adequately address the requirements. Also, requirements in the authorization basis must be reviewed for continued applicability when missions or programs change. When the authorization basis needs to be changed, facilities must request the change, and it must be approved before operating practices are modified.

DOE-STD-1029-92, DOE *Writer's Guide for Technical Procedures*, states that the overall safe operation of the facility depends on the structured interrelationship among DOE requirements and guidance, the basis documentation (senior management, technical, management control, and design), and the facility's procedures—which together are referred to as its safety envelope. In other words, a facility's procedures define how requirements, management philosophies and strategies, and technical knowledge will be integrated and applied to performing work in the facility. Within the facility's safety envelope, the requirements, guidance, and technical and managerial constraints should flow down through the facility's basis documentation and be incorporated in the facility's operations.

Facility managers who have not done so should consider establishing a matrix that links all commitments and requirements to their corresponding implementation vehicles. In Weekly Summary 94-48, NFS reported a good practice at Savannah River that linked databases for compliance with safety requirements. A Defense Nuclear Facilities Safety Board assessment noted the positive aspects of a linking database that relates the requirements of various authorization basis documents to the field implementation of those requirements.

KEYWORDS: authorization basis, basis for interim operation, procedure, technical safety requirement

FUNCTIONAL AREAS: Licensing/Compliance, Procedures

9. FIRE SYSTEM MONITORING IMPAIRED BY POOR COMMUNICATIONS

On July 13, 1999, at the Rocky Flats Environmental Technology Site Plutonium Fabrication Pyrochemical Operations Facility, fire dispatch center personnel discovered that no one had notified them that the facility fire system had been returned to service approximately five days earlier, resulting in the system not being properly monitored. Subcontractor personnel had performed an upgrade on the system, discontinued the fire watches that were required while the maintenance was being performed, and declared the building fire system operational in accordance with a justification for continuing operations. However, the justification for continuing operations did not specifically state that fire dispatch center personnel should be notified before the system was returned to service. As a result, no one told the fire dispatch center to resume monitoring the fire system delta points. Failure to communicate the system status could have delayed fire department's response and could have resulted in facility damage had a fire occurred. (ORPS Report RFO--KHLL-ANALYTOPS-1999-0010)

Investigators determined that fire dispatch center personnel were monitoring the delta points but had identified them as impaired. They determined that had a fire alarm occurred while the delta points were listed as impaired, dispatch center personnel would have called to the facility to determine if the signal was valid before dispatching fire department personnel. However, a shift manager is not present in the facility on nights, weekends, or holidays. If dispatch personnel receive an alarm signal at such time, they are required to call a shift manager at another facility or other personnel to verify if the alarm is valid. Investigators believe that if a valid signal had been received, this alarm verification process could have delayed dispatch of fire department personnel to the facility. Investigators also determined that the site health and safety procedure does require notification of fire protection engineering and fire system services personnel when fire watches are discontinued. DOE personnel are continuing to determine if this constitutes an authorization basis violation.

NFS reported a similar event in Weekly Summary 98-22 involving potential delays in fire department response times at Rocky Flats. Facility personnel performing an independent validation review of the facility authorization basis determined that no official mechanism existed for the fire department to notify facility managers when the minimum response capability could not be met. The facility authorization basis requires the facility manager to suspend operations when the fire department does not have a minimum response capability. The facility authorization basis also requires a specific fire department response time. Facility personnel initiated an unreviewed safety question discovery because the response time may not be met if the fire department is responding to multiple events. (ORPS Report RFO--KHLL-771OPS-1998-0024)

These events underscore the importance of ensuring that fire protection systems are maintained in operational readiness. Work activities that render portions of these systems inoperable need to be controlled and documented. Compensatory measures, such as establishing fire watches, need to be implemented, and facility management must be informed of any change in fire protection system status, including proper notification when systems are returned to service. Facility managers should ensure that work controls are rigorous enough to prevent unplanned system impairments and are adequate to maintain facility and personnel safety during planned impairments. These events also underscore the need for communication between facility managers and personnel who are responsible for monitoring fire protection systems. Prompt notification that impaired or degraded systems have been returned to service is important for facility safety.

- DOE O 420.1, *Facility Safety*, requires fire protection systems for DOE facilities to include means for notifying and evacuating building occupants and means for summoning a fire department. Fire protection supervisory systems detect conditions indicative of fire, actuate local warnings, transmit notifications to a continuously attended location, and in some cases actuate systems to extinguish or limit the spread of fire and smoke. The Order also states that fire protection systems shall be designed such that their inadvertent operation, inactivation, or failure of structural stability will not result in the loss of vital safety functions or inoperability of safety class systems as determined by the safety analysis report.

- DOE O 4330.4B, *Maintenance Management Program,* chapter 15, "Management Involvement," identifies the degree of management involvement in oversight and approval of maintenance activities. Chapter II, section 8.3.1, "Work Control Procedure," states that work control procedures help personnel understand the necessary requirements and controls.

- DOE O 5480.19, *Conduct of Operations Requirements for DOE Facilities*, chapter VIII, "Control of Equipment and System Status," states that DOE facilities are required to establish administrative control programs to handle configuration changes resulting from maintenance, modifications, and testing activities.

NFS has recently issued DOE/EH-0560, Safety Notice 99-01, *Microprocessor-Based Fire Protection System Testing*. This notice contains information on potential fire system vulnerabilities. It also provides recommendations to aid in the identification of system deficiencies and recommends precautionary measures to minimize potential failures or to mitigate the consequences of failure. The notice will be available at http://www.tis.eh.doe.gov/web/oeaf/lessons_learned/ons/ons.html.

KEYWORDS: alarm, fire protection, fire suppression, communication

FUNCTIONAL AREAS: Fire Protection, Industrial Safety, Lessons Learned